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(54) PRODUCTION OF COLD ROLLED STEEL SHEET FOR DEEP DRAWING

(57)Abstract:
PURPOSE: To obtain a cold rolled steel sheet excellent in deep drawability and shape by specifying hot rolling and cooling conditions for an ultra-low carbon steel with specific composition and refining the structure of a hot rolled plate.

CONSTITUTION: A steel consisting of, by weight, 0.0005-0.005% C, ≤0.005% N, ≤0.1% P, ≤0.02% S, ≤0.1% Al, Ti and/or Nb by the amounts satisfying the conditions in $0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93)<1.4$, 0.1-1.5% of one or more elements among Mn, Cr, Cu, Ni, and Mo, and the balance Fe is used. This steel is rolled at a temp. between the Ar3 transformation point and (Ar3 transformation point +100°C) at ≥70% total draft and finish annealing is completed at a temp. not lower than the Ar3 transformation point or rolling is done at a finishing temp. between the Ar3 transformation point and (Ar3 transformation point +50°C) at ≥30% final draft. This steel is cooled from the point of time directly after rolling down to (Ar3 transformation point S-50°C) at ≤50°C/sec average cooling rate, rolled at 0.5-10% draft, coiled at ≤750°C, and successively subjected to ordinary pickling, cold rolling, and annealing.

Claim(s)]
[Claim 1]By weight %, C:0.0005% or more, 0.005% or less, N:0.005% or less, less than aluminum:0.1% is included P:0.1% or less and S:0.02% or less -- either or both sides of Ti and Nb -- $0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93)<1.4$ -- it containing so that conditions may be satisfied, and, One sort or two sorts or more of content of Mn, Si, Cr, Cu, nickel, and Mo 0.1% or more, Steel which consists of the remainder Fe and inevitable impurities at 1.5% or less More than Ar_3 transformation point. A bottom rate of total pressure performs not less than 70% of rolling at least in a temperature region of +100 ** or less of Ar_3 transformation points, End finish rolling above Ar_3 transformation point, and it cools with average cooling velocity of not less than 50 **/sec from immediately after rolling to Ar_3 transformation point-50 **, A manufacturing method of

cold rolled sheet steel for deep drawing carrying out 0.5% or more and 10% or less of rolling after that, and performing rolling up, the usual pickling, cold-rolling, and annealing succeedingly below 750 **.

[Claim 2]By weight %, C:0.0005% or more, 0.005% or less, N:0.005% or less, less than aluminum:0.1% is included P:0.1% or less and S:0.02% or less -- either or both sides of Ti and Nb -- $0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93)<1.4$ -- it containing so that conditions may be satisfied, and, One sort or two sorts or more of content of Mn, Si, Cr, Cu, nickel, and Mo 0.1% or more, Steel which consists of the remainder Fe and inevitable impurities at 1.5% or less more than Ar_3 transformation point with finishing temperature of +50 ** or less of Ar_3 transformation points. And after rolling at not less than 30% of a bottom rate of a ultimate pressure, cooling is started from immediately after rolling, A manufacturing method of cold rolled sheet steel for deep drawing cooling with average cooling velocity of not less than 50 **/sec from immediately after rolling to Ar_3 transformation point-50 **, carrying out 0.5% or more and 10% or less of rolling after that, and performing rolling up, the usual pickling, cold-rolling, and annealing succeedingly below 750 **.

[Detailed Description of the Invention]

[0001]
[Industrial Application]This invention relates to the manufacturing method of cold rolled sheet steel excellent in deep drawability and shape.

[0002]
[Description of the Prior Art]Add Ti and Nb to extremely low carbon steel, and C in steel and N are fixed in the form of a sludge, Many methods of manufacturing the cold rolled sheet steel for deep drawing using IF steel (Interstitial atom free steel) in which the penetration type element of dissolution does not exist are already indicated (for example, JP,58-107414,A, JP,44-18066,B). In order to know that it is effective as a method of raising the deep drawability of the product board after cold-rolled annealing to carry out minuteness making of the hot-rolling board and to attain the minuteness making, The art cooled after hot-rolling as promptly as possible is indicated (for example, JP,58-48635,A, JP,61-276930,A). It is checked by the component system of high tensile steel that it is effective to raise hot-rolling rolling reduction to the method of carrying out minuteness making of the hot-rolling board on the other hand (JP,59-107023,A, JP,58-221258,A). Although minuteness making of some organization can be attained by applying this minuteness making method to extremely low carbon steel, the actual condition is that carry out large pressing-down rolling on the conventional cooling conditions, and the prominent grain-refining effect is not acquired.

[0003]If large pressing-down rolling is performed in a final stage, the shape of a hot-rolling board will deteriorate, it may cause trouble to the operation at the time of cold-rolling, and when it is many, it leads also to degradation of the quality of a final product board. So, under the present circumstances, generally, the rolling reduction of the final

stage is stopped from a viewpoint of shape to 30% or less. Moreover, in the present continuation hot-rolling equipment, since the measuring instrument of the plate shape of the board thickness meter which is a sensor of shape controlling, a board width meter, a crown measuring device, etc. is immediately after a finishing mill, cooling cannot be immediately started after finish rolling. On the other hand, if a cooling system is installed in the finishing mill latest and the measuring instrument of plate shape is installed back, the response of shape controlling will worsen, and the problem of causing controllable degradation exists.

[0004]
[Problem(s) to be Solved by the Invention]This invention optimizes the hot-rolling cooling conditions of extremely low carbon steel, and provides the method of manufacturing the cold rolled sheet steel which was excellent in deep drawability and shape, by carrying out grain refining of the organization of a hot-rolling board.

[0005]
[Means for Solving the Problem]This invention persons did research which carries out minuteness making of the high tension hot rolled sheet steel over many years, and found out that an increase in workability, an increase in a cooling rate, and shortening of cooling time of onset were effective for grain refining. When grain refining of extremely low carbon steel was tried based on this knowledge, it turned out that grain refining is not necessarily promoted by an increase in a cooling rate, and shortening of cooling time of onset with high purification of an ingredient, but a big and rough grain of a columnar crystal generates near the surface. After extremely low carbon steel carried out large pressing-down rolling, even if it cooled it by the usual pattern, grain refining was hardly able to be attained. A place which examined this cause in detail in the experiment using a laboratory-test machine which can control correctly workability, a cooling rate, and cooling time of onset, It turned out that austenite starts recrystallization from immediately after large pressing-down rolling quickly, disappearance of a rearrangement introduced by processing is caused, and minuteness making of a ferrite grain cannot attain enough. Since a rearrangement introduced originally increased based on an increase in workability, it was expected that minuteness making would progress, but since an increase in workability is simultaneously accompanied also by a rise in heat by processing generation of heat, it is thought that disappearance of a rearrangement by a thermal activation process was not able to attain progress grain refining notably, either. With extremely low carbon steel, it is considered to be because for high purification of an ingredient of extremely low carbon steel to have made disappearance of a rearrangement easy by the ability of large pressing-down rolling to attain grain refining in high tensile steel that minuteness making of a remarkable organization was not able to be attained.

[0006]It turned out that cold rolled sheet steel which has the deep drawability which this invention persons considered influence of an ingredient and hot-rolling conditions which are exerted on grain refining and deep drawability of extremely low carbon steel, cooling velocity after hot-rolling, and cooling time of onset, and remarkable grain refining of a hot-rolling board of extremely low carbon steel could be attained only under limited conditions, and was excellent is obtained. A place made into a gist of this invention by

(1) weight % C:0.0005% or more, 0.005% or less, N:0.005% or less, P:0.1% or less, S:0.02% or less, less than aluminum:0.1% is included -- either or both sides of Ti and Nb -- 0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93) <1.4 -- it containing so that conditions may be satisfied, and, One sort or two sorts or more of content of Mn, Si, Cr, Cu, nickel, and Mo 0.1% or more, Steel which consists of the remainder Fe and inevitable impurities at 1.5% or less More than Ar_3 transformation point. A bottom rate of total pressure performs not less than 70% of rolling at least in a temperature region of +100 ** or less of Ar_3 transformation points, End finish rolling above Ar_3 transformation point, and it cools with average cooling velocity of not less than 50 **/sec from immediately after rolling to Ar_3 transformation point-50 **, A manufacturing method of cold rolled sheet steel for deep drawing carrying out 0.5% or more and 10% or less of rolling after that, and performing rolling up, the usual pickling, cold-rolling, and annealing succeedingly below 750 **.

[0007]By weight %, (2) C:0.0005% or more, 0.005% or less, N:0.005% or less, less than aluminum:0.1% is included P:0.1% or less and S:0.02% or less -- either or both sides of Ti and Nb -- 0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93) <1.4 -- it containing so that conditions may be satisfied, and, One sort or two sorts or more of content of Mn, Si, Cr, Cu, nickel, and Mo 0.1% or more, Steel which consists of the remainder Fe and inevitable impurities at 1.5% or less more than Ar_3 transformation point with finishing temperature of +50 ** or less of Ar_3 transformation points. And after rolling at not less than 30% of a bottom rate of a ultimate pressure, cooling is started from immediately after rolling, It cools with average cooling velocity of not less than 50 **/sec from immediately after rolling to Ar_3 transformation point-50 **, 0.5% or more and 10% or less of rolling is carried out after that, and it is in a manufacturing method of cold rolled sheet steel for deep drawing by which it is characterized about performing rolling up, the usual pickling succeedingly, cold-rolling, and annealing below 750 **.

[0008]Below, this invention is explained in detail. An ingredient of this invention is limited from a viewpoint of both minuteness making of an organization, and deep drawability. A maximum of the amount of C and the amount of N was made into 0.005% in order that addition beyond this might degrade deep drawability. A minimum of the amount of C was made into 0.0005% because grain refining of a hot-rolling board did not occur enough but the deep drawability of a final product deteriorated in addition not more than this. A minimum of one sort or two sorts or more of content of Mn, Si, Cr, Cu, nickel, and Mo was made into 0.1% because grain refining of a hot-rolling board did not occur enough but the deep drawability of a final product deteriorated in addition not more than this. A maximum was made into 1.5% in order that addition beyond this might cause degradation of deep drawability. A maximum of an addition of P, S, and aluminum is limited from a moldability, and P and aluminum are because a possibility that a defect will arise in the time of hot-rolling or press working of sheet metal of a product board, etc. becomes high, when S is added 0.02% or more 0.1% or more.

[0009]either or both sides of Ti and Nb -- 0.2<(C/12+N/14+S/32)/(Ti/48+Nb/93) <1.4 -- having limited, when it added so that a relation might be satisfied, It is for pressing down addition of Ti and Nb which can fix a great portion of C and N in steel in a form of a sludge, and become a high cost to the minimum. It is because a steel plate which has the

texture where degrees of location which are directions advantageous to closing (111), such as <112 <225>> (554), are high can be obtained by texture control by rolling if good in the deep drawability of a product to fix C and N in steel. In this invention, it is not 0.0050% or less of thing which spoils the meaning of this invention even if it does B addition of at prevention of a secondary elaboration crack.

[0010]Below, a reason for limitation of a process condition is explained. Although it is the conditions about the 1st invention first, A minimum of a bottom rate of total pressure in a temperature region of +100 ** or less of Ar_3 transformation points was made into 70% more than Ar_3 transformation point because minuteness making of a hot-rolling board was not able to attain enough even if satisfied with a bottom rate of total pressure not more than this of the following cooling conditions, but the deep drawability of a final product deteriorated. When finish rolling was performed at temperature not more than it, finishing temperature of hot-rolling was limited with more than Ar_3 transformation point because a processing grain or a recrystallization grain of a ferrite generated, and sufficient grain refining was not able to be attained but the deep drawability of a final product deteriorated.

[0011]When it cooled with cooling velocity not more than this, average cooling velocity from immediately after rolling to Ar_3 transformation point-50 ** was limited in not less than 50 **/[sec and] because minuteness making of a hot-rolling board was not able to attain enough but the deep drawability of a final product deteriorated. Rolling performed succeedingly is performed for shape amendment, and the minimum rolling reduction required for it is 0.5%. On the other hand, it is because having made a bottom rate of an upper limit of pressure into 10% has a high possibility that big and rough-ization of a figure wax and an organization will take place relaxation of a strain under cooling and in a coiling stage when rolling reduction becomes more than it. And the deep drawability of a final product deteriorates in connection with it. It is because that a maximum of coiling temperature was 750 ** has a high possibility that big and rough-ization of the above-mentioned organization will take place in coiling temperature beyond it.

[0012]Next, although it is the conditions about the 2nd invention, more than Ar_3 transformation point with finishing temperature of +50 ** or less of Ar_3 transformation points. And after rolling at not less than 30% of a bottom rate of a ultimate pressure, it is for limitation of a process condition of starting cooling from immediately after rolling and cooling with average cooling velocity of not less than 50 **/sec from immediately after rolling to Ar_3 transformation point-50 ** carrying out minuteness making of the organization of a hot-rolling board. A processing grain or a recrystallization grain of a ferrite generates that finishing temperature of hot-rolling is below Ar_3 transformation point, and sufficient grain refining cannot be attained. On the other hand, if finishing temperature becomes not less than +50 ** of Ar_3 transformation points, dislocation density in austenite will be low and a ferrite after a transformation will not become detailed.

[0013]A minimum of a bottom rate of a ultimate pressure was made into 30% in order that a ferrite might not do minuteness making notably in rolling reduction not more than

this. However, combination with cooling conditions which carry out the following for attaining remarkable minuteness making is indispensable. That is, cooling is started from immediately after rolling and remarkable minuteness making of this invention steel becomes possible by limiting the cooling velocity. Average cooling velocity from immediately after rolling to Ar_3 transformation point-50 ** was limited in not less than 50 **/s because a ferrite after a transformation became detailed notably by cooling with cooling velocity beyond this.

[0014]Rolling performed succeedingly is performed for shape amendment, and the minimum rolling reduction required for it is 0.5%. On the other hand, it is because having made a bottom rate of an upper limit of pressure into 10% has a high possibility that big and rough-ization of a figure wax and an organization will take place relaxation of a strain under cooling and in a coiling stage when rolling reduction becomes more than it. And the deep drawability of a final product deteriorates in connection with it. It is because that a maximum of coiling temperature was 750 ** has a high possibility that big and rough-ization of the above-mentioned organization will take place in coiling temperature beyond it.

[0015]Although the above-mentioned shape amendment rolling may be performed at any time to less than Ar_3 transformation point-50 ** and rolling up, by using a rolling mill of a final stage of a finishing mill, There is an advantage which can use a measuring instrument of plate shape of a board thickness meter which is a sensor of shape controlling, a board width meter, a crown measuring device, etc. in the present installed position. In this case, a cooling system is installed between paths before a final stage, and by the time it arrives at a final stage, it is necessary to cool to Ar_3 transformation point-50 **. This invention steel passing like an after-cold-rolling plater, and being used as a surface treated steel sheet does not lose the meaning of this invention at all.

[0016]
[Example]
The example of example 1 this invention is described with a comparative example. The steel which has the component composition shown in Table 1 was manufactured on condition of versatility. A transformation point is the value which asked for transformation starting temperature when it cooled in s in 1 ** /using the former star here. The manufacturing conditions of each experiment, the grain size number of a hot-rolling board, the degree of steepness of a hot-rolling board, and the r value of a product board are shown in Table 2. A grain size number is ASTM-No. The degree of steepness expresses a denominator with amplitude, and expresses a numerator with a wave height for the corrugated form of a plate width direction. Slab cooking temperature is 1200 ** and finishing plate thickness is 4 mm. The rate of cold-rolling is 80%, and the continuous annealing furnace performed annealing for 100 seconds at 820 **. However, the experiment 20 performed the alloy plating in a 780 ** continuous hot dip galvanizing line.

[0017]The particle diameter of a hot-rolling board of the experimental run numbers 1, 7, 9, 10, 15, 16, 18, 19, and 20 which are the ranges of this invention is also fine, and their r

value of a product board is also high. The degree of steepness of a hot-rolling board is also small. The material of the experimental run number 2 besides the range of this invention had [the rolling reduction of shape controlling rolling] the large degree of steepness of the hot-rolling board, the workability of cold-rolling was bad, and the defective part existed selectively also in the shape of the product board. On the other hand, the big and rough grain generated selectively the material of the experimental run number 5 whose rolling reduction of shape controlling rolling was larger than the range of this invention with the hot-rolling board, and the r value of the product board did not become high. The same big and rough grain in the hot-rolling board was looked at by the material of the experimental run number 4 whose coiling temperature was beyond the range of this invention. As for the material of the experimental run number 3 below the range of this invention, it did not become detailed [the organization of a hot-rolling board] enough [the average cooling velocity from the end of finish rolling to Ar_3 transformation point-50 **], and the r value of the product board did not become high. With the material of the experimental run number 6 which finishing temperature became below the transformation point, the hot-rolling organization presented the processing organization selectively, and the r value of the product board did not become high.

[0018]As for the material of the experimental run number 8 below the range of this invention, it did not become detailed [the organization of a hot-rolling board] enough [the bottom rate of total pressure in the temperature region of +100 ** of Ar_3 transformation points - Ar_3 transformation point], and the r value of the product board did not become high. Although the organization of the hot-rolling board of the material of the experimental run number 11 in which the amount of C exceeded this invention range was detailed, the r value of the product board did not become high. On the contrary, a hot-rolling board becomes coarse grain and the material of the experimental run number 17 whose amount of C is below this invention range has a comparatively low r value of a product board. As for the material of the experimental run number 12 with which it is not satisfied of the relation between $(C/12+N/14+S/32) / (Ti/48+Nb/93) < 1.4$, the r value of the product board did not become high.

[0019]The hot-rolling board became coarse grain and, as for the material of the experimental run number 13 one sort or two sorts or more of whose content of Mn, Si, Cr, Cu, nickel, and Mo were below the range of this invention, the r value of the product board did not become high. Conversely, although the material of the experimental run number 14 which was added beyond as for the range of this invention becomes detailed in a hot-rolling board organization, the r value of a product board is low. The r value also with an expensive material of the experimental run number 20 of this invention which let the continuation hot-dipping line pass within the limits is obtained, and this invention steel shows the outstanding characteristic also in annealing processes other than continuous annealing. Although not described into front, as for this invention steel, the anisotropy of the r value also became low, and generally in this invention steel in front, the absolute value of deltar was 0.3 or less.

[0020]
[Table 1]

[0021]
[Table 2]

表 1　材料

	C	Si	Mn	P	S	Al	Ti	Nb	B	Cr	Cu	Ni	Mo	N	C/12+N/14+S/32 / Ti/48+Nb/93	Ar₃変態点 (℃)	本発明鋼○ 比較材 ×
A	0.0023	0.01	0.15	0.009	0.012	0.042	0.042							0.0021	0.819	901	○
B	0.0022	0.01	0.13	0.010	0.006	0.025	0.020	0.020						0.0020	0.813	902	○
C	0.0072	0.01	0.20	0.011	0.007	0.033	0.058		0.0002					0.0024	0.819	896	×
D	0.0032	0.01	0.18	0.012	0.006	0.052	0.020							0.0023	1.484	898	×
E	0.0024	0.02	0.05	0.008	0.004	0.043	0.010		0.0002					0.0032	0.634	904	×
F	0.0091	0.02	1.52	0.082	0.003	0.046	0.033		0.0002					0.0028	0.883	833	×
G	0.0025	0.02	0.15	0.072	0.005	0.052	0.012			0.12	0.72	0.35		0.0033	0.636	848	○
H	0.0023	0.01	0.18	0.008	0.004	0.039	0.018		0.0002	0.56			0.12	0.0029	0.523	875	○
I	0.0008	0.01	0.15	0.009	0.005	0.025	0.021		0.0002					0.0025	0.822	906	×
J	0.0008	0.01	0.12	0.011	0.003	0.033	0.045		0.0003					0.0030	0.323	904	○
K	0.0016	0.02	0.15	0.008	0.007	0.052		0.042						0.0030	1.254	899	○

表 2

実験番号	材料	仕上温度 (℃)	Ar_3 ～Ar_3+100 ℃の温度域での全圧下率(%)	仕上圧延終了からAr_3 −50 ℃までの平均冷速 (℃/s)	形状制御圧延圧下率 (%)	捲取温度 (℃)	熱延板の粒度番号 (ASTM)	熱延板の急峻度 (%)	成品板のr値	本発明材○ 比較材 ×
1	A	932	90	70	4	655	11.0	0.92	2.53	○
2	A	926	90	70	0.2	609	10.8	3.82	2.44	×
3	A	930	90	35	4	600	9.8	0.86	2.15	×
4	A	940	90	70	4	754	8.4	1.02	1.98	×
5	A	922	90	70	15	611	8.0	0.77	1.76	×
6	A	872	90	70	4	605	—	0.96	1.77	×
7	A	934	75	70	4	623	10.4	0.96	2.36	○
8	A	935	60	70	4	629	9.3	1.12	2.09	×
9	A	936	90	150	4	336	11.6	1.06	2.63	○
10	B	935	90	70	4	730	11.4	0.98	2.64	○
11	C	926	90	70	4	623	12.3	1.04	2.08	×
12	D	935	90	70	4	629	10.2	1.11	2.18	×
13	E	923	90	70	4	555	9.7	0.95	2.30	×
14	F	878	90	70	4	630	12.5	0.95	1.94	×
15	G	877	90	70	4	640	12.4	0.86	2.30	○
16	H	900	90	70	4	605	12.0	0.99	2.36	○
17	I	935	90	70	4	542	8.3	1.06	2.29	×
18	J	940	90	70	4	562	11.0	0.96	2.73	○
19	K	930	90	70	4	660	12.3	1.10	2.61	○
20	A	933	90	70	4	652	10.9	1.02	2.36	○

[0022]The example of example 2 this invention is described with a comparative example. The steel which has the component composition shown in Table 1 was manufactured on condition of versatility. A transformation point is the value which asked for

transformation starting temperature when it cooled in s in 1 ** /using the former star here. The manufacturing conditions of each experiment, the grain size number of a hot-rolling board, the degree of steepness of a hot-rolling board, and the r value of a product board are shown in Table 3. A grain size number is ASTM-No. The degree of steepness expresses a denominator with amplitude, and expresses a numerator with a wave height for the corrugated form of a plate width direction. Slab cooking temperature is 1200 ** and finishing plate thickness is 4 mm. The rate of cold-rolling is 80%, and the continuous annealing furnace performed annealing for 100 seconds at 820 **. However, the experiment 21 performed the alloy plating in a 780 ** continuous hot dip galvanizing line.

[0023]The particle diameter of a hot-rolling board of the experimental run numbers 21, 22, 29, 31, 35, 36, 38, 39, and 41 which are the ranges of this invention is also fine, and their r value of a product board is also high. The degree of steepness of a hot-rolling board is also small. It did not become detailed [the organization of a hot-rolling board] enough [the material of the experimental run number 23 whose rolling reduction of the final stage was below the range of this invention], and the r value of the product board did not become high. The material of the experimental run number 24 besides the range of this invention had [the rolling reduction of shape controlling rolling] the large degree of steepness of the hot-rolling board, the workability of cold-rolling was bad, and the defective part existed selectively also in the shape of the product board. On the other hand, the big and rough grain generated selectively the material of the experimental run number 27 whose rolling reduction of shape controlling rolling was larger than the range of this invention with the hot-rolling board, and the r value of the product board did not become high. The same big and rough grain in the hot-rolling board was looked at by the material of the experimental run number 26 whose coiling temperature was beyond the range of this invention.

[0024]As for the material of the experimental run number 25 below the range of this invention, it did not become detailed [the organization of a hot-rolling board] enough [the average cooling velocity from the end of finish rolling to Ar_3 transformation point-50 **], and the r value of the product board did not become high. With the material of the experimental run number 28 which finishing temperature became below the transformation point, the hot-rolling organization presented the processing organization selectively, and the r value of the product board did not become high. It did not become detailed [the organization of a hot-rolling board] enough [the material of the experimental run number 40 in which finishing temperature exceeded this invention range], and the r value of the product board did not become high. Although the organization of the hot-rolling board of the material of the experimental run number 30 in which the amount of C exceeded this invention range was detailed, the r value of the product board did not become high. On the contrary, a hot-rolling board becomes coarse grain and the material of the experimental run number 37 whose amount of C is below this invention range has a comparatively low r value of a product board. As for the material of the experimental run number 32 with which it is not satisfied of the relation between $(C/12+N/14+S/32) / (Ti/48+Nb/93) < 1.4$, the r value of the product board did

not become high.

[0025]The hot-rolling board became coarse grain and, as for the material of the experimental run number 33 one sort or two sorts or more of whose content of Mn, Si, Cr, Cu, nickel, and Mo were below the range of this invention, the r value of the product board did not become high. Conversely, although the material of the experimental run number 34 which was added beyond as for the range of this invention becomes detailed in a hot-rolling board organization, the r value of a product board is low. The r value also with an expensive material of the experimental run number 41 of this invention which let the continuation hot-dipping line pass within the limits is obtained, and this invention steel shows the outstanding characteristic also in annealing processes other than continuous annealing. Although not described into front, as for this invention steel, the anisotropy of the r value also became low, and generally in this invention steel in front, the absolute value of deltar was 0.3 or less.

[0026]

[Table 3]

表　3

実験番号	材料	仕上温度(℃)	最終段の圧下率(%)	仕上圧延終了からAr_3 −50℃までの平均冷速(℃/s)	形状制御圧延の圧下率(%)	捲取温度(℃)	熱延板の粒度番号(ASTM)	熱延板の急峻度(%)	成品板のr値	本発明材○ 比較材 ×
21	A	932	40	70	4	655	11.0	0.92	2.53	○
22	A	930	50	70	4	162	11.8	0.98	2.72	○
23	A	928	23	70	4	612	10.2	1.12	2.21	×
24	A	933	40	70	0.2	609	10.8	3.82	2.44	×
25	A	930	40	35	4	600	9.8	0.86	2.15	×
26	A	940	40	70	4	754	8.4	1.02	1.98	×
27	A	922	40	70	15	611	8.0	0.77	1.76	×
28	A	872	40	70	4	605	—	0.98	1.77	×
29	B	935	40	70	4	730	11.4	0.98	2.64	○
30	C	928	40	70	4	623	12.3	1.04	2.08	×
31	B	941	40	150	4	588	12.2	1.23	2.82	○
32	D	935	40	70	4	629	10.2	1.11	2.18	×
33	E	923	40	70	4	555	9.7	0.95	2.30	×
34	F	878	40	70	4	630	12.5	0.95	1.94	×
35	G	877	40	70	4	640	12.4	0.86	2.30	○
36	H	900	40	70	4	605	12.0	0.99	2.36	○
37	I	935	40	70	4	542	8.3	1.06	2.29	×
38	J	940	40	70	4	562	11.0	0.96	2.73	○
39	K	930	40	70	4	660	12.3	1.10	2.64	○
40	A	967	40	70	4	588	10.3	0.97	2.19	×
41	A	933	40	70	4	652	10.9	1.02	2.36	○

[0027]

[Effect of the Invention]The conditions of hot-rolling and cooling are controlled by this invention.

Therefore, it is good, and can manufacture a super-processability steel plate with an r value higher than conventional cold rolled sheet steel, processing of the press material considered for shaping to be impossible once until now is attained, and shape is also a worthy invention industrially.